RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #11

Action Item 9-4
Enhanced Surveillance Processing Test Procedures

8th Draft

Presented by John Van Dongen

SUMMARY
A principal focus of Revision A to the 1090 MOPS is the addition of test procedures for the enhanced surveillance processing techniques. An approach to these test procedures has been discussed at previous meetings. **This Working Paper contains a revised draft of proposed enhanced surveillance processing test procedures based on Action Item 9-4, which requested that the Enhanced Test Procedures be revised to perform tests at 12 above MTL and in addition this paper has revised the test procedures to run the Mode A/C fruit tests with the fruit at multiple levels.**

1.0 Introduction

A principal focus of Revision A to the 1090 MOPS is the addition of test procedures for the enhanced surveillance processing techniques. An approach to these test procedures has been discussed at previous meetings.

This Working Paper contains the 8th draft of proposed enhanced surveillance processing test procedures based on the test concept discussed at the previous meetings of WG-3

2.0 Revised Draft

A revised draft with all of the changes incorporated is presented on the following page.

2.2.4.4 Enhanced Squitter Reception Techniques

2.2.4.4.1 Need for Enhanced Techniques

The squitter reception techniques specified in subparagraph ***TBD*** provide a high probability of correct reception when the desired squitter is overlapped with one Mode A/C interfering reply of equal or greater power. In some high interference environments (e.g., Los Angeles or Frankfurt, Germany), there is a relatively high probability that the desired squitter signal will be overlapped with two or more Mode A/C replies. In these environments, the air-to-air range may be reduced due to the effects of this interference.

2.2.4.4.2 Enhanced Squitter Reception Technique Overview

Enhanced squitter reception techniques have been developed (see Appendix I) that provide the ability to receive squitters with multiple overlapping Mode A/C fruit. Such enhanced reception techniques are composed of the following elements:

a. Improved preamble detection to reduce the probability of a false alarm caused by detection of an apparent Mode S preamble synthesized by overlapped Mode A/C fruit replies.

b. Improved code and confidence bit declaration typically based on the use of amplitude to aid in the interpretation of the squitter data block.

c More capable error correction techniques that are optimized to the characteristics of the code and confidence process.

Equipment intended to meet the minimum requirements for enhanced reception techniques shall demonstrate compliance with the test procedures specified in 2.4.4.4.

2.2.4.4.3 Error Correction Restriction

The enhanced reception techniques are intended to operate in very high Mode A/C fruit environments. For this reason, the sliding window error correction technique shall not be used in connection with the enhanced techniques since it produces an unacceptably high undetected error rate in these high fruit environments.

Note: *See Appendix I, paragraphs I.3.3 and **I.4.3** for more details on error correcting techniques.*

2.4.4.4 Test Procedures for Enhanced Squitter Reception Techniques

2.4.4.4.1 General

Note: *This section defines the tests that are conducted to evaluate the performance of the improved preamble and enhanced squitter reception techniques of the equipment under test.*

The tests consist of injecting a known Mode S extended squitter waveform at a nominal power level with a defined fruit overlap scenario to test the reception of the extended squitter data block. Special waveforms are then injected to test the limits of preamble detection. These tests are followed by a combined test of preamble and data block reception performance. Finally, a test is conducted to verify that the sliding window error correction technique is not used.

The success criteria for the tests require the monitoring of the Mode S extended squitter data content. This data must be available for test monitoring. Report level monitoring is not adequate.

In the following tests, the parameter **T** defines the number of trials that are to be executed. Unless otherwise indicated, **T** equals 1000.

2.4.4.4.2 Test Equipment Requirements

2.4.4.4.2.1 Mode A/C Fruit Signal Source Requirements

Five RF sources shall be provided that are capable of generating Mode A/C 14-pulse replies. Each fruit source shall be capable of the following:

The waveform shall consist of framing pulses and an average of five data pulses. The data content of the fruit reply shall be pseudo randomly varied each time a fruit reply is generated. The data pulses shall be uniformly pseudo randomly distributed across the 12 data bit positions (the **X** pulse position shall not be used).

Each fruit source shall be able to generate ~~an~~ Mode A/C replies~~y~~ at ~~a~~ received power levels ranging from –80 to –60 dBm as required within plus or minus 1 dB. ~~of~~ ~~at least 12 dB above MTL-72 dBm~~ ~~. All five fruit sources shall operate at the same power level, plus or minus 1 dB.~~

The fruit sources should be able to sustain a repetition rate of at least 100 replies per second.

The signals for each of the fruit sources shall be non-coherent with any of the other fruit sources and the extended squitter signal source (2.4.4.4.2.3).

The leading edge of the P1 pulse of the Extended Squitter waveform shall be defined as t=0. The timing of the generation of the beginning of the F1 pulse of each fruit reply shall be controllable to be uniformly pseudo randomly distributed over one of the following intervals (depending on the test):

+ 8 to + 100 microseconds (Extended squitter data block with Mode A/C fruit test)

-20 to +100 microseconds (Combined extended squitter preamble and data block with Mode A/C fruit test)

The pseudo random timing of the generation of fruit replies from each fruit source shall be independent of the timing of the other fruit sources.

2.4.4.4.2.2 Mode S Fruit Signal Source Requirements

One RF source shall be provided that is capable of generating a Mode S 112-bit squitter transmissions as follows:

The signal source shall be able to accept an arbitrary 112-bit format for insertion into the squitter signals.

The Mode S fruit source should be able to sustain a squitter rate of at least 100 squitters per second.

The Mode S fruit source shall be capable of generating a signal power equal to 12 dB above the minimum MTL required for the equipment class being tested within~~power level shall be the same as that used for the Mode A/C fruit,~~ plus or minus 1 dB with no more than 1 dB droop.

The signal for the Mode S fruit source shall be non-coherent with the extended squitter signal source (2.4.4.4.2.3).

The leading edge of the P1 pulse of the Extended Squitter waveform shall be defined as t=0. The timing of the generation of the beginning of the P1 pulse of the Mode S fruit waveform shall be controllable to be uniformly pseudo randomly distributed over the interval +8 to +90 Microseconds.

2.4.4.4.2.3 Extended Squitter Signal Source Requirements

One RF source shall be provided that is capable of generating a 112-bit extended squitter transmissions with no more than 1 dB droop as follows:

The extended squitter power level shall be adjustable to the 7 power levels defined in table 2.4.4.4.2.3 within plus or minus 1 dB for the equipment class being tested. ~~relative to the fruit power level over the following steps (in dB): -12, -8, -4, 0, +4, +8, +12.~~

Table 2.4.4.4.2.3: Extended Squitter Signal Source Power Levels

Equipment Class	Extended Squitter Test Power Levels (dBm)						
A2	-79	-75	-71	-67	-63	-59	-55
A3	-84	-80	-76	-72	-68	-64	-60

The extended squitter signal source should be able to sustain a squitter rate of at least 100 squitters per second.

The contents of the extended squitter transmission shall consist of the five-bit DF field set to 17, an 83-bit field that is set pseudo randomly for each extended squitter transmission except for ME Field bits 1 to 5 (the Format Type Code) which may be set to a fixed value, and a 24-bit PI field appropriate for the content of this transmission.

Provision shall be made to record the contents of each extended squitter transmission

Note: This information is required to check for undetected errors.

2.4.4.4.3 Data Block Tests

2.4.4.4.3.1 Data Block Tests with Mode A/C Fruit

Purpose/Introduction:

The following tests measure the performance of the equipment under test in decoding the extended squitter data content overlapped with Mode A/C fruit. The test series begins with monitoring the reception performance in the absence of interference to establish that the equipment under test is operating correctly.

Next, five tests are conducted with the number of Mode A/C fruit overlaps set to one to five respectively. For each test, the timing of the overlapping fruit is uniformly pseudo randomly distributed across the data block. The fruit power levels will be set according to the test step being conducted and will not change as each of the seven different extended squitter power levels are tested. ~~for seven different relative power levels. For any given test, the power level of all fruit replies is the same set to -72 dBm (plus or minus 1 dB).~~ **T** samples are taken at each power level. Squitters that are declared to be correctly received (i.e., received without errors or successfully error corrected) are compared to the known content of the extended squitter transmission. Any difference between the content of the decoded extended squitter and the known content of the injected squitter is recorded as an undetected error and that squitter reception is removed from the count of successfully received squitters.

The observed probability of correct squitter reception for each relative power level is computed. An average value of the performance across all power levels is computed and compared to the required performance to determine success or failure for the test.

Step 1: Verification of Operation of Equipment Under Test

Connect the extended squitter signal source and set the power level at the receiver input to –84 dBm for A3 equipment class or –79 dBm for A2 equipment class.~~verify that the signal is received at a power level corresponding to the value to be used for the fruit signals.~~ Inject the extended squitter signal **T** times and record the extended squitters that are declared to be output as error free. Compare the decoded content of each extended squitter with the known content of the injected extended squitter. Any differences that are detected are recorded as an undetected error and that squitter reception is deleted from the count of error free receptions.

Calculate the measured probability of correct receptions and the number of undetected errors. The test is passed if the probability of correct receptions is at least 90~~5~~% and there is no more than one undetected error event.

If this test is successful, proceed to Step 2. Otherwise, the test setup and equipment under test should be checked and Step 1 is repeated.

Step 2: Test with One Mode A/C Fruit Overlap

Set the extended squitter signal source as specified in Step 1.

Set the power level of one Mode A/C fruit source at the receiver input to –72 dBm for A3 equipment class or –67 dBm for A2 equipment class.

Activate the~~one~~ Mode A/C fruit source so that the fruit is pseudo randomly distributed across the extended squitter data block as specified in 2.4.4.4.2.1.

~~Set the extended squitter power to -12 dB relative to the Mode A/C fruit signal level.~~

Inject the extended squitter waveform **T** times and record the receptions that are declared to be error free. Check for undetected errors and adjust as necessary the number of correctly received replies as specified in Step 1. Calculate the measured probability of correct reception and the number of undetected errors.

Repeat the above step for the remaining six extended squitter power levels according to the equipment class being tested:~~relative powers of -8, -4, 0, +4, +8, +12 dB.~~

Ext. Sq. Power Levels A2: -75, -71, -67, -63, -59, -55 dBm

Ext. Sq. Power Levels A3: -80, -76, -72, -68, -64, -60 dBm

Calculate the average probability of reception and the total number of undetected errors across the seven power levels.

Step 3: Test with Two Mode A/C Fruit Overlaps

Repeat Step 2 with two fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -69, -65 dBm

Fruit Power Levels A3: -74, -70 dBm

Step 4: Test with Three Mode A/C Fruit Overlaps

Repeat Step 2 with three fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -71, -67, -63 dBm

Fruit Power Levels A3: -76, -72, -68 dBm

Step 5: Test with Four Mode A/C Fruit Overlaps

Repeat Step 2 with four fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -73, -69, -65, -61 dBm

Fruit Power Levels A3: -78, -74, -70, -66 dBm

Step 6: Test with Five Mode A/C Fruit Overlaps

Repeat Step 2 with five fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -75, -71, -67, -63, -59 dBm

Fruit Power Levels A3: -80, -76, -72, -68, -64 dBm

Step 7: Determination of Success or Failure

Compare the results recorded above with the requirements in Table 2.4.4.4.3.1.

Table 2.4.4.4.3.1: Success Criteria for Data Block Tests with Mode A/C Fruit

Number of Fruit	**1**	**2**	**3**	**4**	**5**
Minimum Probability					
Max Undetected Errors	1	1	1	1	1

2.4.4.4.3.2 Data Block Tests with Mode S Fruit

Purpose/Introduction:

The following tests measure the performance of the equipment under test in decoding the extended squitter data content overlapped with Mode S fruit. The test series begins with monitoring the reception performance in the absence of interference to establish that the equipment under test is operating correctly.

Next, a test is conducted with a single Mode S fruit overlap. For this test, the timing of the overlapping fruit is uniformly pseudo randomly distributed across the data block for four different relative power levels. **T** samples are taken at each power level. Squitters that are declared to be correctly received (i.e., received without errors or successfully error corrected) are compared to the known content of the extended squitter transmission. Any difference between the content of the decoded extended squitter and the known content of the injected squitter is recorded as an undetected error and that squitter reception is removed from the count of successfully received squitters.

Finally, the observed probability of correct squitter reception for each relative power level is computed.

Step 1: Verification of Operation of Equipment Under Test

Connect the extended squitter signal source and verify that the signal is received at a power level corresponding to ~~*TBD* –~~–72 dBm for A3 equipment class or –67 dBm for A2 equipment class.. Inject the signal **T** times and record the extended squitters that are declared to be output as error free. Compare the decoded content of each extended squitter with the known content of the injected extended squitter. Any differences that are detected are recorded as an undetected error and that squitter reception is deleted from the count of error free receptions.

Calculate the measured probability of correct receptions and the number of undetected errors. The test is passed if the probability of correct receptions is at least 95% and there is no more than one undetected error event.

If this test is successful, proceed to Step 2. Otherwise, the test setup and equipment under test should be checked and Step 1 is repeated.

Step 2: Test with One Mode S Fruit Overlap

Set the extended squitter signal source as specified in Step 1.

Activate the Mode S fruit source so that the Mode S fruit is pseudo randomly distributed across the data extended squitter data block as specified in 2.4.4.4.2.2.

Set the extended squitter power to 0 dB relative to the Mode S fruit signal level.

Inject the extended squitter waveform **T** times and record the receptions that are declared to be error free. Check for undetected errors and adjust as necessary the number of correctly received replies as specified in Step 1. Calculate the measured probability of correct reception and the number of undetected errors.

Repeat the above step for relative powers of signal to interference (S/I) of +4, +8, and + 12 dB.

Calculate the probability of correct reception and the number of undetected errors for each of the four power levels.

Step 3: Determination of Success or Failure

Compare the results recorded above with the requirements in Table 2.4.4.4.3.2.

Table 2.4.4.4.3.2: Success Criteria for Data Block Tests with Mode S Fruit

Relative Power, (S/I) dB	**0**	**+4**	**+8**	**+12**
Minimum Probability				
Max Undetected Errors	1	1	1	1

2.4.4.4.4 Four-Pulse Preamble Detection Tests

Purpose/Introduction:

These tests verify that the ADS-B reply processor correctly detects the presence of a valid ADS-B preamble whose pulse characteristics are within the allowable limits and rejects preambles having pulse spacing and position characteristics that are outside the allowable limits.

<u>Reference Input:</u>

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz
Frequency	=	1090 MHz
Power	=	23 dBm (for the first preamble pulse level)

<u>Input A:</u>

Same as the **Reference Input**, but having the following preamble pulse characteristics:

<u>Table 2.4.4.4.4.A:</u> Input A: Preamble Pulse Characteristics

Input A: Preamble Pulse Characteristics					
Pulse	**Rise time** (µsec)	**Fall time** (µsec)	D **Width** (µsec)	D **Position** (µsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	+0.05	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.05	+0.125	+2
3	0.05 - 0.1	0.05 - 0.2	+0.05	+0.125	+2
4	0.05 - 0.1	0.05 - 0.2	-0.05	+0.125	0

<u>Input B:</u>

Same as the **Reference Input**, but having the following preamble pulse characteristics:

<u>Table 2.4.4.4.4.B:</u> Input B: Preamble Pulse Characteristics

Input B: Preamble Pulse Characteristics					
Pulse	**Rise time** (µsec)	**Fall time** (µsec)	D **Width** (µsec)	D **Position** (µsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	+0.05	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.05	-0.125	+2
3	0.05 - 0.1	0.05 - 0.2	+0.05	-0.125	+2
4	0.05 - 0.1	0.05 - 0.2	-0.05	-0.125	0

Input C:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2.4.4.4.4.C: Input C: Preamble Pulse Characteristics

Input C: Preamble Pulse Characteristics					
Pulse	**Rise time** (μsec)	**Fall time** (μsec)	D **Width** (μsec)	D **Position** (μsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	-0.3	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.3	0	0
3	0.05 - 0.1	0.05 - 0.2	-0.3	0	0
4	0.05 - 0.1	0.05 - 0.2	-0.3	0	0

Input D:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2.4.4.4.4.D: Input D: Preamble Pulse Characteristics

Input D: Preamble Pulse Characteristics					
Pulse	**Rise time** (μsec)	**Fall time** (μsec)	D **Width** (μsec)	D **Position** (μsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	+0.2	0
3	0.05 - 0.1	0.05 - 0.2	0	+0.2	0
4	0.05 - 0.1	0.05 - 0.2	0	+0.2	0

Input E:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2.4.4.4.4.E: Input E: Preamble Pulse Characteristics

Input E: Preamble Pulse Characteristics					
Pulse	**Rise time** (μsec)	**Fall time** (μsec)	D **Width** (μsec)	D **Position** (μsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	-0.125	0
3	0.05 - 0.1	0.05 - 0.2	0	0	0
4	0.05 - 0.1	0.05 - 0.2	0	+0.125	0

Input F:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2.4.4.4.4.F: Input F: Preamble Pulse Characteristics

Input F: Preamble Pulse Characteristics					
Pulse	**Rise time** (μsec)	**Fall time** (μsec)	D **Width** (μsec)	D **Position** (μsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	0	0
3	0.05 - 0.1	0.05 - 0.2	0	+0.125	0
4	0.05 - 0.1	0.05 - 0.2	0	-0.125	0

Input G:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2.4.4.4.4.G: Input G: Preamble Pulse Characteristics

Input G: Preamble Pulse Characteristics					
Pulse	**Rise time** (μsec)	**Fall time** (μsec)	D **Width** (μsec)	D **Position** (μsec)	D **Amplitude** (dB)
1	0.05 - 0.1	0.05 - 0.2	+4.5	—	—
2	Pulse Not Present				
3	Pulse Not Present				
4	Pulse Not Present				

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level is adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures is lowered by 3 dB.

Step 1: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 1

Apply **Input A** at the receiver input and verify that at least 90 percent of the ADS-B messages are correctly decoded.

Step 2: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 2

Repeat Step 1 with the signal power level at -65 dBm.

Step 3: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 3

Apply **Input B** at the receiver input and verify that at least 90 percent of the ADS-B messages are correctly decoded.

Step 4: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 4

Repeat Step 3 with the signal power level at -65 dBm.

Step 5: Preamble Pulse Widths set to Out-of-Tolerance Values - Part 1

Apply **Input C** at the receiver input and verify that no more than 10 percent of the ADS-B messages are correctly decoded.

Step 6: Preamble Pulse Widths set to Out-of-Tolerance Values - Part 2

Repeat Step 5 with the signal power level at -65 dBm.

Step 7: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 1

Apply **Input D** at the receiver input and verify that no more than 10 percent of the ADS-B messages are correctly decoded.

Step 8: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 2

Repeat Step 7 with the signal power level at -65 dBm.

Step 9: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 3

Apply **Input E** at the receiver input and verify that no more than 10 percent of the ADS-B messages are correctly decoded.

Step 10: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 4

Repeat Step 9 with the signal power level at -65 dBm.

Step 11: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 5

Apply **Input F** at the receiver input and verify that no more than 10 percent of the ADS-B messages are correctly decoded.

Step 12: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 6

Repeat Step 11 with the signal power level at -65 dBm.

Step 13: Preamble Single Pulse - Part 1

Apply **Input G** at the receiver input and verify that no more than 10 percent of the ADS-B messages are correctly decoded.

Step 14: Preamble Single Pulse - Part 2

Repeat Step 13 with the signal power level at -65 dBm.

2.4.4.4.5 Preamble Validation Tests

Purpose/Introduction:

These tests verify that the ADS-B reply processor correctly validates the ADS-B preamble. It is verified that when energy is contained in at least one chip of the first five data bits the preamble is accepted and the preamble is rejected if one or more of the first five data bits has no energy in either chip.

Reference Input:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

“DF”	=	17
“CA”	=	0
“AA”	=	Any discrete address
Message Rate	=	50 Hz
Frequency	=	1090 MHz
Power	=	23 dBm

The transmitted power in the first six data bits is controlled in such a way that a data bit can occur with no power being transmitted in either chip.

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level is adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures is lowered by 3 dB.

For this test to be valid the receiver must perform error correction.

Step 1: Preamble Validation – Missing First Data Bit - Part 1

Input the DF=17 messages with no energy in either chip of the first data bit into the receiver and verify that less than 10 percent of the ADS-B messages are correctly decoded.

Step 2: Preamble Validation – Missing First Data Bit - Part 2

Repeat Step 1 with the signal power level at -65 dBm.

Step 3: Preamble Validation – Missing Second Data Bit - Part 1

Input the DF=17 messages with no energy in either chip of the second data bit into the receiver and verify that less than 10 percent of the ADS-B messages are correctly decoded.

Step 4: Preamble Validation – Missing Second Data Bit - Part 2

Repeat Step 3 with the signal power level at -65 dBm.

Step 5: Preamble Validation – Missing Third Data Bit - Part 1

Input the DF=17 messages with no energy in either chip of the third data bit into the receiver and verify that less than 10 percent of the ADS-B messages are correctly decoded.

Step 6: Preamble Validation – Missing Third Data Bit - Part 2

Repeat Step 5 with the signal power level at -65 dBm.

Step 7: Preamble Validation – Missing Fourth Data Bit - Part 1

Input the DF=17 messages with no energy in either chip of the first data bit into the receiver and verify that less than 10 percent of the ADS-B messages are correctly decoded.

Step 8: Preamble Validation – Missing Fourth Data Bit - Part 2

Repeat Step 7 with the signal power level at -65 dBm.

Step 9: Preamble Validation – Missing Fifth Data Bit - Part 1

Input the DF=17 messages with no energy in either chip of the fifth data bit into the receiver and verify that less than 10 percent of the ADS-B messages are correctly decoded.

Step 10: Preamble Validation – Missing Fifth Data Bit - Part 2

Repeat Step 9 with the signal power level at -65 dBm.

Step 11: Preamble Validation – Missing Sixth Data Bit - Part 1

Input the DF=17 messages with no energy in either chip of the sixth data bit into the receiver and verify that greater than 90 percent of the ADS-B messages are correctly decoded.

Step 12: Preamble Validation – Missing Sixth Data Bit - Part 2

Repeat Step 11 with the signal power level at -65 dBm.

2.4.4.4.6 Combined Preamble and Data Block Tests with Mode A/C Fruit

Purpose/Introduction:

The following tests measure the performance of the equipment under test in decoding the extended squitter preamble and data block overlapped with Mode A/C fruit. The test series begins with monitoring the reception performance in the absence of interference to establish that the equipment under test is operating correctly.

Next, five tests are conducted with the number of Mode A/C fruit overlaps set to one to five respectively. For each test, the timing of the overlapping fruit is uniformly pseudo randomly distributed across the preamble and data block for seven different relative power levels. The fruit power levels will be set according to the test step being conducted and will not change as each of the seven different extended squitter power levels are tested. ~~For any given test, the power level of all fruit replies is the sameset to –72 dBm (plus or minus 1 dB).~~ **T** samples are taken at each power level. Squitters that are declared to be correctly received (i.e., received without errors or successfully error corrected) are compared to the known content of the extended squitter transmission. Any difference between the content of the decoded extended squitter and the known content of the injected squitter is recorded as an undetected error and that squitter reception is removed from the count of successfully received squitters.

The observed probability of correct squitter reception for each relative power level is computed. An average value of the performance across all power levels is computed and compared to the required performance to determine success or failure for the test.

Step 1: Verification of Operation of Equipment Under Test

Connect the extended squitter signal source and set the power level at the receiver input to –84 dBm for A3 equipment class or –79 dBm for A2 equipment class.~~verify that the signal is received at a power level corresponding to the value to be used for the fruit signals.~~ Inject the extended squitter signal **T** times and record the extended squitters that are declared to be output as error free. Compare the decoded content of each extended squitter with the known content of the injected extended squitter. Any differences that are detected are recorded as an undetected error and that squitter reception is deleted from the count of error free receptions.

Calculate the measured probability of correct receptions and the number of undetected errors. The test is passed if the probability of correct receptions is at least 9~~5~~0% and there is no more than one undetected error event.

If this test is successful, proceed to Step 2. Otherwise, the test setup and equipment under test should be checked and Step 1 is repeated.

Step 2: Test with One Mode A/C Fruit Overlap

Set the extended squitter signal source as specified in Step 1.

Set the power level of one Mode A/C fruit source at the receiver input to –72 dBm for A3 equipment class or –67 dBm for A2 equipment class.

Activate the~~one~~ Mode A/C fruit source so that the fruit is pseudo randomly distributed across the extended squitter preamble and data block as specified in 2.4.4.4.2.1.

~~Set the extended squitter power to -12 dB relative to the Mode A/C fruit signal level.~~

Inject the extended squitter waveform **T** times and record the receptions that are declared to be error free. Check for undetected errors and adjust as necessary the number of correctly received replies as specified in Step 1. Calculate the measured probability of correct reception and the number of undetected errors.

Repeat the above step for the remaining six extended squitter power levels according to the equipment class being tested:~~for relative powers of -8, -4, 0, +4, +8, +12 dB.~~

Ext. Sq. Power Levels A2: -75, -71, -67, -63, -59, -55 dBm

Ext. Sq. Power Levels A3: -80, -76, -72, -68, -64, -60 dBm

Calculate the average probability of reception and the total number of undetected errors across the seven power levels.

Step 3: Test with Two Mode A/C Fruit Overlaps

Repeat Step 2 with two fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -69, -65 dBm

Fruit Power Levels A3: -74, -70 dBm

Step 4: Test with Three Mode A/C Fruit Overlaps

Repeat Step 2 with three fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -71, -67, -63 dBm

Fruit Power Levels A3: -76, -72, -68 dBm

Step 5: Test with Four Mode A/C Fruit Overlaps

Repeat Step 2 with four fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -73, -69, -65, -61 dBm

Fruit Power Levels A3: -78, -74, -70, -66 dBm

Step 6: Test with Five Mode A/C Fruit Overlaps

Repeat Step 2 with five fruit overlaps set to the following power levels and record the results~~.~~:

Fruit Power Levels A2: -75, -71, -67, -63, -59 dBm

Fruit Power Levels A3: -80, -76, -72, -68, -64 dBm

Step 7: Determination of Success or Failure

Compare the results recorded above with the requirements in Table 2.4.4.4.6.1.

Table 2.4.4.4.6.1: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit

Number of Fruit	**1**	**2**	**3**	**4**	**5**
Minimum Probability					
Max Undetected Errors	1	1	1	1	1

2.4.4.4.7 Test to Verify the Sliding Window Error Correction Is Not Used

TBD